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(54) **Bifocal contact lenses.**

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Description

This invention relates to contact lenses and in particular to bifocal and trifocal contact lenses.

Conventional bifocal contact lenses can be divided into two main types, i.e.

1. Concentric bifocals in which the distance vision zone is in the centre and the reading or near vision zone is a peripheral ring or toroid around the central area. Occasionally the zones are reversed.

2. Bifocals which resemble scaled-down spectacle bifocal lenses. These lenses comprise two D-shaped segments, the lower segment being the near vision zone.

In the case of the first type, the size of the central zone is critical, particularly if the lens is fitted tightly to the cornea so that little movement occurs on blinking. The amount of light entering the eye from the distant and near vision zones must be approximately equal, otherwise vision will be biased towards either distance or reading. As the pupil diameter is not static but varies according to the brightness of the light, a compromise must be made in selecting the size of the central zone. This problem is made worse by the fact that the difference in pupil size between the maximum and minimum varies from person to person.

Bifocal lenses of the second type generally have to be fitted slightly looser so that the lens can move over the cornea so that when the wearer is looking straight ahead the line dividing the two segments is below the centre of the pupil, while for reading the opposite situation applies. Thus the location of the dividing line between the distance and reading zones is critical for satisfactory fitting of this type of lens. Although variations in pupil size are less important in the case of this type they can affect the result.

For these reasons a large measure of trial and error inevitably occurs in fitting bifocal lenses of both types, and the practitioner therefore requires a very large inventory to cover all the necessary permutations.

A major object of this invention therefore is to provide bifocal lenses wherein pupil diameter and pupil fluctuations have little or no influence on the fitting of the lenses. In order to avoid unnecessary repetition the term "bifocal" is used in the following description and claims to include trifocal lenses, where the context admits.

The bifocal lens having the features of the precharacterizing part of Claim 1 is known from US—A—4210391. According to the present invention, there is provided a bifocal contact lens having a front, convex surface and a back, concave surface and a viewing area divided into near and distant vision zones, each near vision zone being adjacent to a distant vision zone and there being at least 2 zones of each kind in said viewing area, and each zone being capable of operating as a lens independently of the other zones, characterised in that the plurality of said vision zones are formed as a profile in the back surface of the lens, and the ratio of the total area of the distant vision zones to the total area of the near vision zones is from about 60:40 to 40:60.

In most lenses in accordance with the invention there will be more than 2 of each type of viewing zone, e.g. 6 or 8 or more.

Generally, the distant vision zones will substantially equal in total surface area the near vision zones of the lens, i.e. the ratio of the areas of the near and distant vision zones will be in the range of from about 60:40 to 40:60.

It is unnecessary for the whole surface of the lens to be divided into zones of different powers since it is only the portion of the lens which covers the pupil at its maximum opening which is normally used in vision correction.

There are many possible ways in which the surface of the lens can be divided geometrically into near and distant vision zones. The particular arrangement selected will depend in part on the method of manufacture adopted. For example, where the lens is manufactured on a lens lathe, the back surface may be formed with a series of concentric areas, each annular area being cut alternately for distant and near vision.

Another technique for producing zones of different power in the lens is to incorporate segments of material having a different refractive index from that of the body of the lens. Using this approach the lens can be machined or moulded with a single power curvature, the different focal lengths of the near and distant vision zones being achieved by the difference in their refractive indices or by a combination of the differences in refractive indices and curvature.

Various embodiments of bifocal lenses in accordance with the invention will now be described by way of illustration only, with reference to the accompanying drawings in which:-

Figure 1 is a front plan view of one kind of bifocal lens,

Figure 2 is a plan view of the front of another lens in accordance with the invention,

Figure 3 is a plan view of the front of a third lens in accordance with the invention,

Figure 4 is a plan view of the front surface of a fourth lens in accordance with the invention.

In Figure 1, a lens is shown having near and distant viewing zones formed as a series of concentric rings.

The shaded rings 1 denote the near vision viewing zones while the unshaded rings 2 denote the distant viewing zones. Of course, in reality, the rings 1 and 2 are equally transparent. These roles can however be reversed. As illustrated the central area 3 of the lens has a focal length which is appropriate for distant viewing while the adjacent zone 1 has a focal length appropriate for near vision viewing.

Another specific arrangement is illustrated in Figure 2, in which the surface of the lens has a general background zone 11 whose focal length is appropriate for near vision viewing (i.e. it has a power which is more positive than the distant vision zones of the lens). The distant vision area

comprises a multiplicity of generally circular zones 12 umiformly dispersed over the power surface of the lens. One of the circular zones 13 is centred on the axis of the lens and the sum of the total surface areas of all the circular zones 12 is substantially equal to half the total surface area of the power surface of the lens.

A modification of this lens is shown in Figure 3. In this modification the background zone 31 is again the near vision viewing area of the lens and the circular zones 32 are provided for distant vision. An area 34 for distant vision is located at the optical centre of the lens. Segments 33 are arranged around the periphery of the lens and these are intended for distant vision viewing, or alternatively for median distance viewing, where the lens is trifocal. The lenses shown in Figures 2 and 3 would preferably be manufactured by moulding but it would be possible to manufacture these embodiments by polishing a lens, whose power curve has been cut for distant vision, through a mask having apertures which correspond to zones 12 and 13. One half of a mould may be made using a metal block in which a number of cylindrical pegs, corresponding to the zones 12 and 13, are retractably mounted (but are not rotable) in the block. A first concave curve is cut on the tops of the pegs to correspond to the distant vision prescription and the pegs are then retracted into the block. A second concave curve is than cut in the block to form the reading zone curvature. When the pegs are extended to a position where their peripheries are coincident with the curved surface of the block, a moulding surface is produced for the profile of a lens as shown in Figure 2. Of course the reverse procedure could be adopted, and the reading zones could be cut on the pegs and the distant vision zones cut on the block.

Although in the lenses shown in Figures 1 to 3, the zones of different power cover the whole surface of the lens, this is unnecessary since the extreme peripheral area of the lens is not normally used for viewing.

A type of configuration which is currently preferred is shown in Figure 4. In this lens, the power surface is divided into sectors which radiate from the axis of the lens and are alternatively near vision sectors 41 and distant vision sectors 42. Near vision sectors 41 consist of portions of transparent material which preferably have a higher refractive index than that of the rest of the lens comprising the sectors 42 and the peripheral area 43. As vision through the centre of the lens may be distorted if the sectors continued to the geometric centre of the lens it is preferred that the sectors 41 stop short of the centre so that the central portion 44 has the same power as that of sectors 42 and the periphery 43.

When manufacturing hard lenses, typical materials are polymethyl methacrylate and copolymers thereof, polyesters and polymers and copolymers of styrene. Polyesters and polymers containing styrene have a higher refractive index than polymethacrylates or polyacrylates.

Referring to Figure 4, the diameter 'd' of the area covered by the sectors 41 is typically about 6 mm., while the overall diameter will be about 9 to 10 mm. for a hard lens or about 13 to 14 mm. for a soft lens. With a typical closeness of fitting, the lens will tend to move over a distance of about 2 mm. Since pupil diameter in average bright intensity is about 4 mm., the pupil area will remain covered at all times by the area defined by the sectors. Because substantially equal amounts of light reach the pupil through the sectors 41 and the zones 42 over substantially the whole of this area fitting of the lens becomes independant of the pupil size and fluctuations in pupil size with different light conditions.

While casting and machining are the preferred methods of producing lenses in accordance with the invention, it may be possible to utilize injection or compression moulding techniques.

It will be appreciated that configurations other than those shown in the accompanying drawings are possible. For example, the major viewing areas may be formed as a series of small contiguous polygonal zones, e.g. hexagons (as seen in plan). Preferably these zones are arranged so that there is substantially uniform distribution of polygonal near vision zones and distant vision zones over the major viewing area.

Preferably the lens shown in Figure 4 has about 4 to 20 sectors, generally 6 to 10. Some of the sectors may be for middle distance viewing.

Lenses manufactured in accordance with the invention may be hard or soft and produced by polymerisation of the known monomer mixtures. In the case of soft lenses, the lenses are machined in hard conditions and, after shaping and polishing, swollen in the usual isotonic swelling solutions. When manufacturing by moulding, a degassed polymerisation mixture is poured into a suitably shaped mould half, the mould is closed with the other mould half and the mixture maintained at a controlled temperature or temperature cycle usually between 40°C. and 100°C., until polymerisation is substantially complete. The castings are removed from the moulds, polished (if necessary) and swollen in an appropriate aqueous solution e.g. isotonic saline. A variety of polymerisation recipes are possible, for example, as described in British Patents Nos. 1,385,677 and 1,475,605 (De Carle), 829,565 (Wichterle) and 1,436,705 (N.R.D.C.), the disclosure of which is specifically imported herein.

It is a surprising feature of the lenses of the present invention that although the wearer will actually be able to look through two or more zones of different focal length at the same time, after a short acclimatisation period, the wearer learns to discriminate between the images and to ignore the images which are out of focus. After a while, the wearer is no longer conscious that he is seeing several images but is only aware of the one which is in focus, for the particular object or view he is looking at. This situation is achieved so long as the relative zones of distant and near vision (or distant, middle and near vision) por-

tions of the lens are essentially in balance. Thus for a bifocal lens I aim to have approximately half the total viewed area each for distant and near vision. It is however possible to depart somewhat from the 50/50 situation and, for example, provide zones in the relative proportion of 60/40 or 40/60. Also it may be preferable not to distribute the areas entirely uniformly and perhaps provide a greater area of reading vision towards the periphery of the lens.

Claims

1. A bifocal contact lens having a front, convex surface and a back, concave surface and a viewing area divided into near and distant vision zones, each near vision zone being adjacent to a distant vision zone and there being at least 2 zones of each kind in said viewing area, and each zone being capable of operating as a lens independently of the other zones, charcterised in that the plurality of said vision zones are formed as a profile in the back surface of the lens, and the ratio of the total area of the distant vision zones to the total area of the near vision zones is from about 60:40 to 40:60.

2. A lens according to claim 1, wherein the near and distant vision zones comprise a plurality of annular, concentric zones.

3. A lens according to claim 1 or claim 2, wherein the near and distant vision zones are formed in the concave surface of the lens by machining.

4. A lens according to claim 2, wherein the distribution of near and distant vision zones is such that there is a greater proportion of near vision area in the region of the periphery of the lens.

5. A lens according to claim 1 wherein there are between about 2 and about 8 zones of each kind in said viewing area.

6. A lens according to claim 5 in which there is a central circular area consisting of a distant vision zone located at the optical centre of the lens.

7. A lens according to claim 5 or claim 6 in which the distant vision zones comprise a plurality of generally circular areas distributed over a surface of the lens.

8. A lens according to claim 5 or 6 in which the near vision zones comprise a plurality of generally circular areas distributed over a surface of the lens.

9. A lens according to claims 7 or 8 in which the distant and near vision zones are produced by machining the front or back surface of the lens.

10. A bifocal contact lens according to claim 1 having a viewing area which is divided into sectors radiating outwardly from an axis of the lens wherein adjacent sectors constitute near and distant vision zones having a first power and a second power respectively and wherein the ratio of the total area of the near vision zones to the total area of the distant vision zones is from about 60:40 to 40:60.

11. A lens according to claim 10 in which the sectors radiate from a central area which is of one of said powers.

12. A lens according to claims 10 or 11 in which the sectors result from the presence in the body of the lens of segments of transparent plastics material having a different refractive index from that of the body of the lens.

13. A lens according to claim 10 in which the segments have a higher power than the remainder of the lens because their curvature is steeper than that of the remainder of the lens.

14. A lens according to any one of the preceding claims formed by casting at least one polymerisable liquid monomer composition.

15. A lens according to any one of the preceding claims which is a soft lens.

Patentansprüche

1. Bifokale Kontaktlinse mit einer konvexen Vorderseite und einer konkaven Rückseite und mit einer Sichtfläche, die in eine Nah- und Fernsehzone unterteilt ist, wobei jede Nahsehzone sich neben einer Fernsehzone befindet und zumindest 2 Zonen von jeder Art in der Sichtfläche vorhanden sind und jede Zone als eine Linse unabhängig von den anderen Zonen funktionieren kann, dadurch gekennzeichnet, daß die Vielzahl der Sehzonen als ein Profil in der Rückseite der Linse ausgebildet ist und das Verhältnis der Gesamtfläche der Fernsehzonen zur Gesamtfläche der Nahsehzonen ungefähr 60:40 bis 40:60 beträgt.

2. Linse nach Anspruch 1, dadurch gekennzeichnet, daß die Nahund Fernsehzone eine Vielzahl von ringförmigen konzentrischen Zonen aufweisen.

3. Linse nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die Nah- und Fernsehzone in der konkaven Fläche der Linse durch maschinelle Bearbeitung gebildet werden.

4. Linse nach Anspruch 2, dadurch gekennzeichnet, daß die Verteilung der Nah- und Fernsehzone derart ist, daß ein größerer Anteil an Nahsehfläche im Bereich der Peripherie der Linse vorhanden ist.

5. Linse nach Anspruch 1, dadurch gekennzeichnet, daß zwischen ungefähr 2 und ungefähr 8 Zonen jeder Art in der Sichtfläche vorhanden sind.

6. Linse nach Anspruch 5, dadurch gekennzeichnet, daß eine zentrale kreisförmige Fläche, die aus einer im optischen Zentrum der Linse angeordneten Fernsehzone besteht, vorhanden ist.

7. Linse nach Anspruch 5 oder 6, dadurch gekennzeichnet, daß die Fernsehzonen eine Vielzahl von allgemein kreisförmigen Flächen, die über eine Oberfläche der Linse verteilt sind, aufweisen.

8. Linse nach Anspruch 5 oder 6, dadurch gekennzeichnet, daß die Nahsehzonen eine Vielzahl von allgemein kreisförmigen Flächen, die über eine Oberfläche der Linse verteilt sind, aufweisen.

9. Linse nach Anspruch 7 oder 8, dadurch gekennzeichnet, daß die Fern- und Nahsehzonen durch maschinelle Bearbeitung der Vorder- oder Rückseite der Linse hergestellt werden.

10. Bifokale Kontaktlinse nach Anspruch 1 mit einer Sichtfläche, die in Sektoren unterteilt ist, die sich radial von einer Achse der Linse nach außen ausbreiten, wobei benachbarte Sektoren Nah- und Fernsehzonen mit einer ersten bzw. zweiten Stärke darstellen und wobei das Verhältnis der Gesamtfläche der Nahsehzonen zur Gesamtfläche der Fernsehzonen ungefähr 60:40 bis 40:60 beträgt.

11. Linse nach Anspruch 10, dadurch gekennzeichnet, daß sich die Sektoren von einer zentralen Fläche, die eine der Stärken ist, radial ausbreiten.

12. Linse nach Anspruch 10 oder 11, dadurch gekennzeichnet, daß die Sektoren durch die Gegenwart von Segmenten aus transparentem Kunststoff im Linsenkörper mit einem vom Linsenkörper unterschiedlichen Brechnungsindex gebildet werden.

13. Linse nach Anspruch 10, dadurch gekennzeichnet, daß die Segmente eine größere Stärke als der Rest der Linse aufweisen, da ihre Wölbung steiler als die des Restes der Linse ist.

14. Linse nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß durch Vergießen von mindestens einer polymerisierbaren flüssigen Monomerzusammensetzung hergestellt ist.

15. Linse nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß sie eine weiche Linse ist.

Revendications

1. Une lentille de contact bifocale comportant une face avant convexe, une face arrière concave et une surface de vue divisée en des zones de vision de près et de loin, chaque zone de vision de près étant adjacente à une zone de vision de loin et au moins 2 zones de chaque type existant sur ladite surface de vue, et chaque zone pouvant opérer comme lentille indépendamment des autres zones, caractérisée en ce que la pluralité desdites zones de vision sont formées sous la forme d'un profil de la face arrière de la lentille, et le rapport de l'aire totale des zones de vision de loin à l'aire totale des zones de vision de près est environ de 60/40 à 40/60.

2. Une lentille selon la revendication 1, dans laquelle les zones de vision de près et de loin comportent une pluralité de zones annulaires concentriques.

3. Une lentille selon la revendication 1, ou la revendication 2, dans laquelle les zones de vision de près et de loin sont formées par usinage de la face concave de la lentille.

4. Une lentille selon la revendication 2, dans laquelle la distribution des zones de vision de près et de loin est telle qu'il existe une plus grande proportion d'aire de vision de près dans la région de la périphérie de la lentille.

5. Une lentille selon la revendication 1, dans laquelle il existe d'environ 2 à environ 8 zones de chaque type dans ladite surface de vue.

6. Une lentille selon la revendication 5, dans laquelle il existe une surface centrale circulaire constituée d'une zone de vision de loin et située au centre optique de la lentille.

7. Une lentille selon la revendication 5 ou la revendication 6, dans laquelle les zones de vision de loin comportent une pluralité de surfaces dans l'ensemble circulaires distribuées sur une face de la lentille.

8. Une lentille selon la revendication 5 ou 6, dans laquelle les zones de vision de près comportent une pluralité de surfaces dans l'ensemble circulaires distribuées sur une face de la lentille.

9. Une lentille selon la revendication 7 ou 8, dans laquelle les zones de vision de loin et de près sont réalisées par usinage de la face avant ou arrière de la lentille.

10. Une lentille de contact bifocale selon la revendication 1, comportant une surface de vue qui est divisée en secteurs suivant des rayons en allant vers l'extérieur à partir d'un axe de la lentille, dans laquelle des secteurs adjacents constituent des zones de vision de près et de loin présentant respectivement une première puissance et une seconde puissance, et dans laquelle le rapport de l'aire totale des zones de vision de près à l'aire totale des zones de vision de loin est d'environ 60:40 à 40:60.

11. Une lentille selon la revendication 10, dans laquelle les secteurs sont disposés suivant des rayons à partir d'une surface centrale qui présente l'une desdites puissances.

12. Une lentille selon la revendication 10 ou 11, dans laquelle les secteurs résultent de la présence dans le corps de la lentille de segments de matière plastique transparente présentant un indice de réfraction différent de celui du corps de la lentille.

13. Une lentille selon la revendication 10, dans laquelle les segments présentent une puissance plus forte que le reste de la lentille du fait que leur courbure est plus forte que celle du reste de la lentille.

14. Une lentille selon l'une quelconque des revendications précédentes, formée par moulage d'au moins une composition monomère liquide polymérisable.

15. Une lentille selon l'une quelconque des revendications précédentes, qui est une lentille molle.

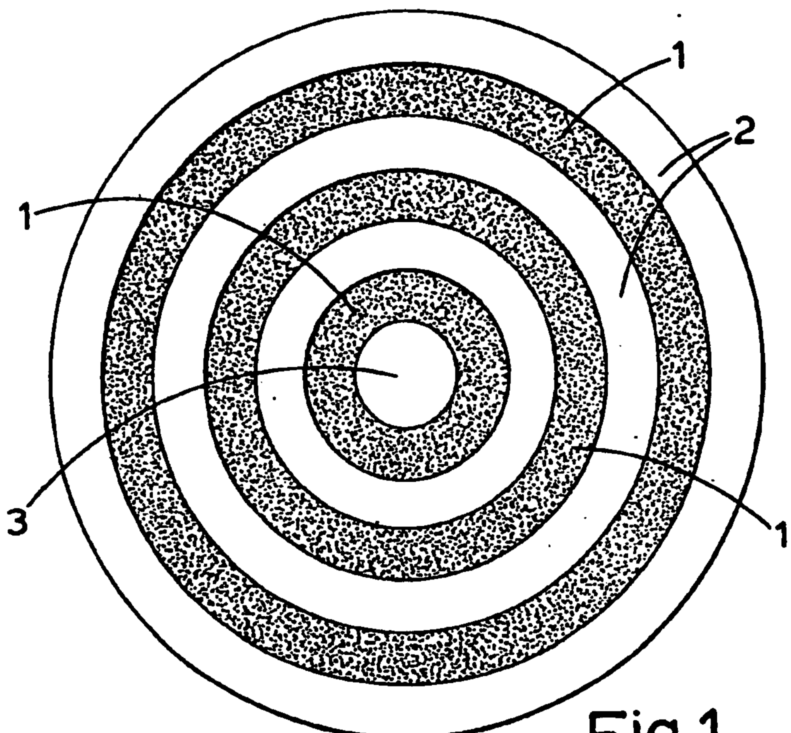

Fig.1

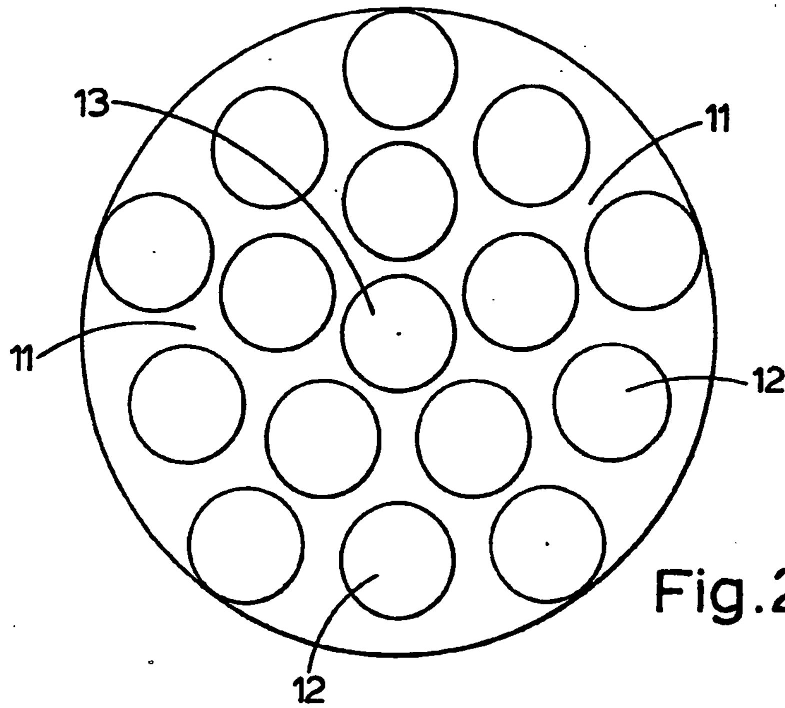

Fig.2

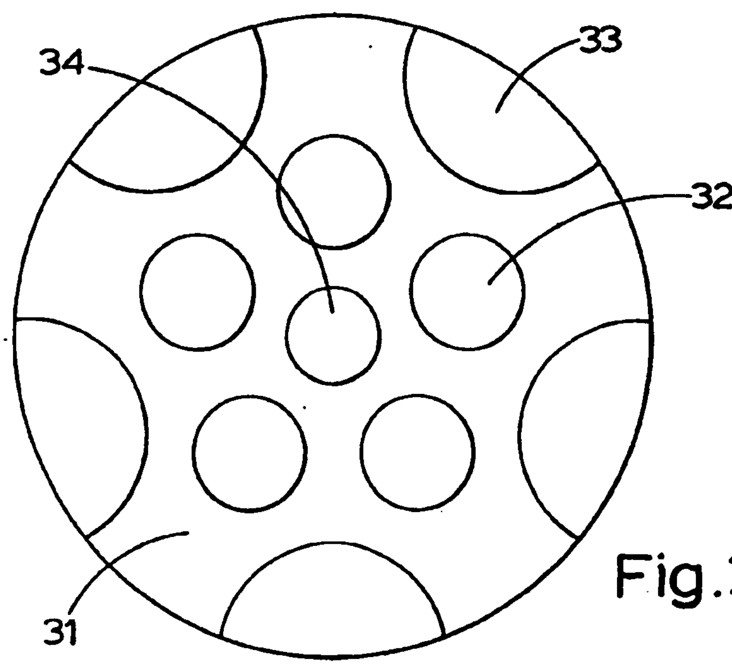

Fig.3

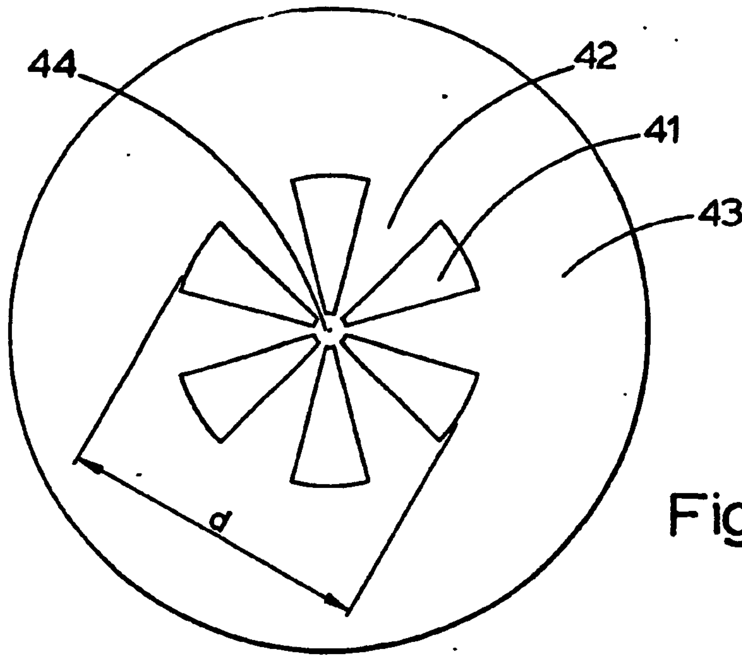

Fig.4